MINUTES OF INFORMAL CONFERENCE ON THE CODLING MOTH HELD IN WASHINGTON, D.C., JANUARY 4, 1928.

An informal conference was held January 4, 1928, in the office of Dr. A. L. Quaintance, Associate Chief of the Bureau of Entomology and chairman of the committee on cooperation of Federal and State workers on the codling moth, with especial reference to the spray-residue situation. This committee was appointed last year by the American Association of Economic Entomologists to formulate plans for cooperative investigations to be carried out by different workers during the season of 1927. The membership of this committee is as follows: Dr. A. L. Quaintance, chairman; Prof. Geo. A. Dean, Prof. P. J. Parrott, Prof. W. P. Flint, Mr. LeRoy Childs, and Dr. B. A. Porter.

The conferees present at the informal meeting presented results of the work accomplished during 1927 and made suggestions for work during 1928, as set forth in the following pages. State workers present at the conference were:

Dr. T. J. Headlee,	New Jersey Agricultural Experiment Station, New Brunswick, N.J.
Mr. H. N. Worthley,	Pennsylvania State College, State College, Pa.
Prof. J. S. Houser,	Ohio Agricultural Experiment Station, Wooster, O.
Prof. J. J. Davis,	Purdue University, Lafayette, Ind.
Prof. P. J. Parrott,	Agricultural Experiment Station, Geneva, N.Y.
Prof. L. M. Peairs,	Agricultural Experiment Station, Morgantown, W.Va.
Prof. Leonard Haseman,	University of Missouri, Columbia, Mo.
Mr. H. S. McConnell,	University of Maryland, College Park, Md.
Prof. W. P. Flint,	University of Illinois, Urbana, Ill.
Prof. Geo. A. Dean,	Agricultural College, Manhattan, Kans.
Dr. W. S. Hough,	Polytechnic Institute, Winchester, Va.

Bureau of Entomology workers present were: Dr. A. L. Quaintance, Dr. B. A. Porter, Dr. C. H. Richardson, Dr. F. L. Campbell, Dr. N. E. McIndoo, Dr. A. Peterson, Mr. E. J. Newcomer, Mr. A. J. Ackerman, Mr. E. H. Siegler, Mr. L. Brown, Mr. R. F. Sazama, Mr. R. E. Snodgrass, Mr. E. R. Van Leeuwen, Mr. G. A. Runner, Mr. J. A. Hyslop.

Dr. R. C. Roark, of the Bureau of Chemistry and Soils, and Dr. W. A. Hooker, of the Office of Experiment Stations, were also present.

Statement of Prof. George A. Dean:

Our work in Kansas has been in direct charge of Dr. P. M. Gilmer of the Bureau, assisted by Mr. Howard Baker, another Bureau man, and Dr. Parker, one of the men from my department. Dr. Gilmer and Mr. Baker were in the field all the time. The work in Kansas was simply with the various substitutes and also on banding work, particularly bands treated with some chemical or material that might kill the larvae that were crawling in beneath the bands for pupation. I may say first, however, that climatic conditions were more favorable for us this year. I think it will probably be best for me to read a paragraph or two from the summary of the work prepared by Dr. Gilmer.

Climatic conditions were more nearly similar in the two sections this year than usual. In northeastern Kansas the fruit belt which extends along the Missouri River and over into Missouri as well as up into Nebraska is an entirely different belt from that in southern Kansas, where the soil is very sandy. This year the climatic conditions in the two districts were much more similar than they usually are. Very little hot weather was experienced and the rainfall was very heavy, especially during the times that the hibernating and first-brood moths were most prevalent. Rains also cut the number of second-brood moths very considerably. Temperatures in the early spring were conducive to an early emergence of the hibernating brood, while late afternoon and sundown temperatures were too low for oviposition. This resulted in the death of a large proportion of the overwintering individuals without egg-laying, reducing the number of first-generation worms markedly. The first moths were noted as early as April 15 at Wichita, while the first worm found was a full month later. Conditions in the northern sections were somewhat similar although the interval between the first emergence and first oviposition was undoubtedly shorter by some days.

Cool days and rather cold nights characterized the earlier part of the season, making the time in the egg stage long. This resulted in weak worms many of which died without entering the apples. Fully 20% of the injuries on the check blocks in the early-season counts were stings only. This was even more marked in the sprayed fruit and all substances seemed to offer fair satisfaction for the first two sprays.

Later in the season the temperature became more favorable and the late first-brood and second-brood worms were normal. The numbers were, however, markedly reduced by the small percent of first-brood worms that survived, and in some blocks before the second brood came on attacked apples were found only with difficulty. All of the substitutes practically fell down with the exception of a supplementary treatment of oil. We used the Volck oil and it even fell down when it was used alone but used with either lead arsenate or calcium arsenate it gave fairly good results and the apples sprayed with Volck and arsenate of lead had an unusually fine red color. The Missouri Pippin and Winesap had a most beautiful dark-red color. In all tests with these substitutes some burning resulted. Some of the substitutes completely defoliated the trees. With the exception of zinc compounds, the burning was not serious on the apples but was very severe on the leaves, especially with the zinc and calcium arsenates. The materials tried were magnesium arsenate, manganese arsenate, calcium arsenate, lead arsenate, barium arsenate, zinc arsenate, zinc arsenite, ferrous arsenate, aluminum arsenate, tricalcium arsenate and lead arsenate and Volck. There was even some burning with lead. The burning with aluminum arsenate was not severe. The control with the aluminum was better than the other substitutes, but not as good as the lead arsenate. Some of the orchardists in southern Kansas used 2 pounds and some even 3 pounds of arsenate of lead for the calyx spray and first two cover sprays. Those who were using 2 pounds secured much better control than those using one and one and a half.

The field observations led to the belief that the effect of oil may be far more mechanical than chemical. A large number of the larvae observed were unable to attach silk to gain foothold nor were they able to get a hold with their mandibles.

Banding work was undertaken using a number of chemicals for treatment. In the southern section we failed to obtain any results that were worthy of record but in the northern section the results were good. Bands of cheesecloth and burlap were used both alone and with the cloth beneath the burlap. The burlap bands gave the best results. The materials used were very heavy oil (Standard Diamond steam cylinder oil), beta naphthol and tar oil. They were used on all of the various types of bands and checked against a burlap untreated check. The oil, beta naphthol, gave best results with the heavy oil alone second. This was very effective for about a month but lost its efficiency late in the season. The oil-naphthol bands gave about 85% kill which approaches that of hand-run bands. This year no injury was noticed but we do not know what may happen if the banding is continued for two or three years. Some injury may result, but apparently there was no injury from the band of the steam cylinder oil or beta naphthol this year.

In summarizing will say, that the substitutes, with the exception of aluminum arsenate, failed miserably, and with many of them severe burning of the leaves was had. No washing of the sprayed fruit was done by the orchardists.

Statement of Mr. E. R. VanLeeuwen:

Several phases of the codling-moth problem were carried out during the past summer. One phase was the field spraying experiments conducted with nicotine sulphate and arsenate of lead in one of the heaviest infested orchards in the Riverton, N. J., district. One plat was sprayed with six applications of lead arsenate, and another plat with three applications of lead arsenate against the first-brood larvae, followed by three applications of nicotine sulphate against the second-brood larvae. In the plat receiving the six applications of lead arsenate, the percentage of apples free from worms was 90.65, while in the plat sprayed with lead arsenate and nicotine sulphate, the percentage of apples free from worms was 87.11. The apples in the unsprayed plat were 66.76% free from worms. These results would indicate that there might be some promise in using nicotine in preventing an excess of arsenic on the fruit at harvest. The trees were absolutely drenched and a super job of spraying was done. It is astonishing, however, to note that when apples, taken from the lead arsenate sprayed plat, were brought to the Laboratory and subjected to newly hatched larvae, many of the larvae were able to enter.

In another orchard, lead arsenate was used with nicotine sulphate, pyrethrum, and Derris in various plats. We found that three early applications of lead arsenate against the first brood followed by three applications of pyrethrum, nicotine, or Derris against the second brood gave good results. Check trees showed 83% of all apples free from worms, whereas the lead-arsenate plat showed 97%, nicotine 95%, pyrethrum 93%, and Derris 95% free from worms.

For several years we have been making tests with many arsenical substitutes, and although we have nothing definite to state, I can say that we are making some headway. After five years of testing with arsenical substitutes, I begin to feel that it is a pretty hard job to find something which will take the place of lead arsenate. Many of the substitutes do not remain on the foliage, others cause injury, many are expensive, and so we have a number of difficulties to overcome. Using newly hatched codling moth larvae, laboratory tests were made with many arsenicals and other toxic materials. Of all the poisons tested, lead arsenate gave the most consistent results. In the laboratory tests, the following materials compared more or less favorable with lead arsenate: Manganese arsenate, calcium arsenate, tricalcium arsenate, basic lead arsenate, barium fluosilicate, and sodium fluosilicate. Derris, pyrethrum, and nicotine gave very encouraging results, and further laboratory tests will be made. Calcium caseinate when added to the arsenate sprays increased the percentage of entrances compared with the arsenate used alone.

Some work was also done in the field in studying the behavior of 101 newly hatched larvae, and also a study of the behavior of 29 individual matured larvae was made. It was found that when the trunk of an apple tree was scraped of all rough bark, and a burlap band placed around it, it would catch approximately 20 per cent of the larvae placed on the tree.

Fourteen insecticides were tested in the orchard for foliage injury, and severe "burning" of the foliage was secured with many of them. The materials which showed no foliage injury from as high as four applications were as follows:

Scorodite, ferric arsenate, aluminum arsenate, basic lead arsenate, and acid lead arsenate, and barium fluosilicate.

Statement of Prof. W. P. Flint:

Our work in Illinois followed somewhat the same lines that Mr. Van Leeuwen just reported upon. We made some studies in an attempt to obtain definite information on the exact places where the larvae were hibernating in the orchard. Of course it takes a large number of such examinations before conclusions can be drawn. Touching on the work this year some things might be of interest. In southern Illinois, where most of these examinations were made by Mr. S. C. Chandler, we tried to find where the larvae were hibernating in the orchards. These examinations were made in six different orchards, some of which had been unsprayed, some sprayed and banded. They showed that approximately one-third of the overwintering larvae which pass the winter on the trees spin their cocoons about the bases of the tree trunks from one inch above to one inch below the surface of the soil. Those up on the trunk were very largely killed by birds and weather, but at the ground line most of the larvae were protected from the birds and adverse weather.

Another series of studies was made to see where larvae could be found that were not on the trunks of the trees. We found a large number of larvae away from the trunks, 90% of these found in what could be termed "man-made shelters," in old baskets, or picking bags, mouse-poison stations, discarded nitrate sacks, and old clothing. Forty-two were found in one mouse-poison station.

Our main orchard experimental work last year was stopped by a freeze the 22d of April which killed all the apples in our orchard. In the western Illinois plots tests were made of magnesium arsenate, calcium arsenate, and lead arsenate. Lead arsenate was used for the first-brood sprays and white oil emulsion for the second, lead arsenate and a white oil emulsion with an insecticide added in the emulsion. In other plots sulphur and copper dusts were used throughout the season. One test was made of spraying for the first brood and dusting for the second. There were 15 blocks in all and our results came out about the same as those reported by Professor Dean. The substitutes were very much inferior to lead arsenate. In all of these sprays, standard fungicides were used with the poisons, that is, lime sulphur early in the season during cool weather and Bordeaux later when the weather was hot. Magnesium arsenate had 40% entrances and 2.2% curculio. Calcium arsenate has given good results for two years in this section, but has resulted in some burning. In only two cases did we get arsenical residue in excess of the tolerated amount, 0.01 grain per pound.

A large series of tests were run with some of the arsenical substitutes, trying them on some truck-crop insects, using three species of cabbage worms. Lead arsenate was the only one that gave satisfactory control. Aluminum arsenate corresponded to Professor Dean's report. No satisfactory substitute for arsenate of lead was found.

Some work was carried on with bands. A tarred-paper band gave the best catch of moths, and the next best was a bagging material with loose cotton threads on the inside of the band. In the treated bands we used several compounds including fluosilicates. From these we secured as high as 87% kill from freshly treated bands. On the whole for the season, I think 56% kill was secured from treated bands.

In the tests with different banding materials conducted in southern Illinois, a band with a tarred paper back and cotton thread face, a material ordinarily used for bagging, was considerably better than any other material tried. Another similar band faced with burlap gave a very good catch of larvae. The cotton faced band collected over one-third or 36% of all of the codling moth larvae taken under 126 bands, including 14 bands of each of 9 different types of material. A crepe paper with an asphalt interlining, making the paper light proof, gave fairly good results. Several types of tar-paper bands gave a fair catch of larvae, but were not as good as those mentioned.

In a somewhat larger series of experiments, run in orchards near Urbana, a tarred paper of the grade known as asphalt felt, gave the best catch of codling moth larvae. These bands were put in place during July and were only examined three times during the season, on August 18, August 30th, and finally during the latter part of October. The average numbers caught are shown on the following table:

Name of paper	Average number of larvae per band Aug. 18	Aug. 30	Oct.13	Average per tree per examination.
1. Asphalt felt	2.55	4.7	368.3	125.1
2. Tar paper	2.08	7.1	310.5	106.7
3. Asphalt felt	.87	3.1	230.3	78.1
4. Light-proof paper faced with burlap	2.75	6.12	215.5	74.8
5. Asphalt felt	1.4	4.33	191.7	65.5
6. Crepe paper, light proof	2.33	4.1	178.3	61.8
7. Cotton-faced light-proof paper	3.00	5.27	163.6	57.5
8. Plain black paper (no tar)	.4	.1	152.7	56.3
9. Kraft paper	2.4	6.6	139.5	55.9
10. Heavy paper, light proof	1.06	4.5	140.5	51.5
11. Insulating fabric (tar)	.18	1.5	143.1	50.8

Statement of Dr. Alvah Peterson:

All of our work with the codling moth has been done in conjunction with our studies on the oriental peach moth. Three distinct phases will be reported on at this time.

Lights.- In studying the response of codling moths and oriental peach moths to colored lights we learned that both species are attracted to colors near the violet end of the spectrum such as blue, violet, and ultra-violet. Both species are nearly blind to red. Also orange and green are not very attractive.

Spring-brood emergence. Spring-brood emergence of adults is best determined by overwintering larvae spun up in corrugated paper and placed in open cages. There should be eight cages, four on the ground and four several feet (5-7) above ground. The individual cages of each group of four faced north, east, south, and west. The first adults appeared in the south cages on the ground and the last cage which produced adults was located on the north side several feet above the ground. The combined emergence in the eight cages coincides closely with the actual emergence in the orchard.

The emergence of adults in vials placed in covered wooden boxes was two or three weeks later than normal emergence in the orchard. The emergence of material kept in a packing house was 25 to 30 days later than the emergence in the screen cages in the orchard.

The differences in the emergence are due to differences in temperature. The influence of the direct rays of sunlight on temperature and the emergence is much greater than appreciated heretofore.

Parasites.- This past year a study was made of the life cycle and biology of Ascogaster carpocapsae and Trichogramma minutum.

Ascogaster parasitizes readily the codling moth and oriental peach moth under insectary conditions. We have not been able to assemble the information which we have obtained, consequently I can not give a very satisfactory report on this species at present. I am of the opinion that Ascogaster will not be a very satisfactory parasite to try and produce in large numbers.

Trichogramma is a most valuable parasite. It readily attacks the eggs of the codling moth and the oriental peach moth. In codling-moth eggs it may complete its development in as short a time as eight days during the warm summer weather or it may take 30 to 40 days in the fall when the temperature is much lower. One to six individuals may be produced in one egg. Two or three are quite common. So far we have individuals of Trichogramma overwintering in the eggs of the Mediterranean meal moth. Whenever warm days appear when the temperature goes to 50°F, some of the adults emerge. It is probable that Trichogramma does not overwinter in the eggs of the codling moth or the oriental peach moth because these eggs are not deposited late enough in the fall to overcome the influence of sufficiently high temperatures in October and November to bring about a completion of the life cycle of the parasite in the host eggs. Trichogramma may be reared under insectary and laboratory conditions in large numbers. Several hosts may be used, the Angoumois grain moth, the Mediterranean meal moth, and others.

Under orchard conditions Trichogramma appears to be fairly abundant late in the season. As a rule it is absent or occurs in small numbers early in the summer. If one could liberate, in the orchard, large numbers of adult parasites early in the summer when the first-brood eggs of the codling moth are abundant then a decided reduction of the host might occur.

At one time there was a nicotine product on the market called nicotine resinate. We tried it out for the peach-tree borer. We made an analysis of the material after it was placed on peach trees. It gave a definite reaction to nicotine as much as three weeks after it was on the tree, while nicotine sulphate disappeared in three days.

Discussion

Mr. Newcomer: We introduced the Ascogaster parasite seven or eight years ago and find it parasitized one-third of the worms. We took 25,000 worms out of the bands this summer and one-third were parasitized. These parasites (Trichogramma) can be produced artifically in large numbers. Childs, in Hood River, found as many as seven or eight Trichogramma coming from a single egg. If the parasite could be reared in large numbers and liberated when the codling moth starts laying eggs in the spring, it looks possible to get them with it. This would probably have to be done every year but the cost would not be any more to the grower than the cost of spraying.

Statement of Prof. L. M. Peairs:

Tests of various insecticides for the control of the codling moth were made in a small orchard consisting mainly of York Imperial trees. This included tests of one, two, three, and four applications of arsenate of lead and parallel tests with calcium arsenate, magnesium arsenate, sodium fluosilicate, calcium fluosilicate, and barium carbonate.

Results from four plots receiving four applications showed best results from arsenate of lead, magnesium arsenate second, calcium arsenate third, with the other materials less effective. Results were influenced by heavy rains during the spraying period which disarranged the spray schedule to some extent and by the fact that the infestation in the check plots was low as compared with mid-west and far west conditions, as the check plots showed only about 15% of infested apples. Band records were taken from a considerable number of trees.

Work for the coming season is to be concentrated mainly on the determination of a satisfactory substitute for arsenate of lead, to be used in applications for second-brood codling moth only, as it is felt that there is no particular need for a substitute material for the earlier sprays. We, therefore, plan to use several materials, notably the fluosilicates in liquid sprays and as dust, to see if any of them are effective in reducing the infestation of second-brood worms. Orchard sanitation methods and band records will be kept as before.

Statement of Professor Leonard Haseman:

We continued our dusting and spraying experiments for the third year and devoted a good deal of time this year to breeding work. We feel there must be something associated with the method of application or time of application which enabled some of our growers in the same community to get practically perfect fruit while others have much wormy fruit.

Our breeding records were quite different from those reported for Kansas. Our emergence generally was very late, as much as 20 to 30 days later in some sections and the peak of emergence generally was much later than normal. Former students in Southeast, Southwest, West-Central, Northwest and Northeast Missouri cooperated with the Department in the breeding cage record work. They wired the Department when their first moth or moths emerged and again when they estimated that the peak was reached. These records were immediately sent to the growers in the different apple growing sections of the State. The cooperators also kept daily emergence records which they later mailed in. After all, or practically all moths of the first brood had emerged the cages were emptied and refilled with wormy apples for securing second brood moth emergence. While, due to prolonged emergence, the broods tended to overlap we were able to quite definitely report to our growers the first emergence and the date on which the peak occurred for each brood.

This service was of great help to the growers of Central and North Missouri in planning their spray schedule. Had it not been for the emergence records, the growers in Central Missouri would have completed all the spray applications which they ordinarily apply for the first brood of worms, before the first worms began to enter the fruit. This breeding cage work will be continued and extended this year and bait traps will be used to supplement it.

In the southern part of the State we had very little fruit. The same frost reported in southern Illinois also struck our Ozark section, though some of the orchards had a fair crop. Where the crop was lost, a few of the growers conceived the idea that they would pick the remaining apples and thus starve out the apple worms. They held a meeting and attempted to get the growers to agree to pick the few scattering apples, but nothing was accomplished. Some of the growers who had light crops made one or two spray applications after the frost came, but no definite figures are available on the spraying and dusting work in the Ozarks.

In the orchard in Central Missouri where we conducted the spraying and dusting experiment this year there was a high infestation of side worms due to late pin-worms but a low calyx infestation.

The following is a summary of the results with liquid sprays, dusts and combination of liquids and dusts:

Plot	Insecticide	No. applications	Percent of calyx worms	Percent of side worms
1	90-10	6	5.42	33.95
2	Copper prepared	6	5.51	27.06
3	Liquid L.S.-Lead	6	4.89	30.83
4	Liquid & Dust 3 liquid 4 cover dust	7	8.81	39.46

Unfortunately, in the orchards we did not have sufficient blotch or scab to be able to determine the comparative value of the fungicide in the dust and spray applications.

For the coming year we are planning to cooperate with Dr. Gilmer of the Bureau in an extensive project in the St. Joseph region. We also expect to continue the dusting experiments at Columbia. Besides enlarging the scope of the breeding cage work mentioned above we will conduct a state-wide test of bands and baits. We will also do further work on the problem of lethal dosage and apparent resistance of some strains to arsenic.

Statement of Dr. R. C. Roark:

The question of sampling is a very important one. Very little has been done on it and we are trying to get some data on the subject. We had Mr. Newcomer send us one lot of 400 apples from one sprayed orchard and we are analyzing the fruit at the present time. Each apple is being analyzed separately for arsenic. The figures will be treated statistically and we will then be in a position to know just what proportion of apples in a sprayed orchard it is necessary to send in, so that the sample accurately represents the entire lot of sprayed apples. This will be some factor times the square root of the total number of apples.

The Bureau of Chemistry has recently completed a study of the problem of sampling linseed meal. We analyzed, separately, 100 bags of linseed meal and determined the nitrogen. The nitrogen in these 100 bags, expressed as ammonia, varied from 5 to 7½%. The individual results were treated statistically. For a result accurate to 0.2% it would be necessary to sample 4 out of 100 bags. In that case the factor is 0.4 times the square root. We know that in a sprayed orchard the residue on different apples varies tremendously; in one case 25 times as much arsenic as another. The greater the variation the larger sample it will be necessary to take if we want a high degree of accuracy. It is probable we will find the number of apples necessary to send in as samples will be so large that it will be impractical to deal in such large numbers, and for this reason we will have to sacrifice somewhat in our accuracy.

Statement of Mr. A. J. Ackerman:

In the Ozark region of Arkansas we have been concerned with a serious codling moth problem for a good many years. During the course of our work in the past eight or nine years we came to the conclusion that our original recommendation of a few years ago of one pound of lead arsenate to fifty gallons and seven spray applications which we usually applied, was not sufficient to control the worms. We have tried to recommend other materials in combination and came to the conclusion, about 1925, that to control a bad infestation it is necessary to use a higher dosage of lead arsenate, and that lead arsenate really was the only material giving us control. We have also done a great deal of work with sanitary measures, probably more than in any other part of the country, all in addition to our spraying work. Of course in 1926, and during the past season, we had the spray residue problem come up and we came to the conclusion that we had some recommendations we could give to the growers that would actually give them a commercial control of the codling moth, although it might necessitate cleaning the fruit. Our recommendation in the past two years has been a spray of 2 lbs. of lead arsenate, at least in the more important applications, then dropping

down to a pound or a pound and a half of lead arsenate. Our work this year has been with some of the substitutes for arsenate of lead, and I might say that our infestation this year was very light. Our crop was also very light. We used six substitutes for arsenate of lead. In comparison with arsenate of lead in one orchard these six substitutes were practically worthless for codling moth commercial spraying. Arsenate of lead gave a control of 96%. In another orchard we added on some tests, using one pound of arsenate of lead to fifty gallons, which we consider inadequate for control. We had a light infestation this year and our unsprayed plat showed only 44% wormy. At 1 - 50 we got 92% clean fruit. At 2 - 50 we got 97% clean fruit. A plat sprayed with only arsenate of lead at 1-50 in the seven sprays with an oil insecticide added in the last four sprays gave us practically the same control as 2-50 (97% clean fruit). One plat sprayed with arsenate of lead in the first three applications and the last four applications with oil alone gave us a control of 93%. A plat sprayed with arsenate of lead in the first three applications and dusted in the last four applications gave us a control of about 78%. Dust gave disastrous results in past years in the Ozarks. Our experimental dusting was done just about dusk, the one time of the day when we would have a little calm. We tried to put our dust on our experimental work in the best way we could and dusted both sides of the trees, dusting for the last four applications only. The application of arsenate of lead at 1-50 in the first three applications, followed by nicotine sulphate in the last four applications, gave a control of 88%. With our 1-50 arsenate of lead in seven applications we had a residue of 0.027 grain per lb.; with 2-50 we had 0.086; and with 1-50 lead added to oil we had 0.09. The unsprayed check really was not an unsprayed check because our crop had been killed out and the grower had already sprayed calyx in this orchard, so that all the fruit had received the calyx application. Analyses made by the Food, Drug, and Insecticide Administration at St. Louis is not anything in line with the analyses received from Washington. In other words, numerous analyses from commercial orchards sprayed as heavy and heavier than we sprayed in our experimental work showed that most of the growers got under 0.01 and a few growers that had their fruit seized this year had no excuse for spraying the way they did, using seven applications of oil and two pounds of lead arsenate throughout the season.

Statement of Dr. N. E. McIndoo:

I have been occupied with the tropic responses of codling-moth larvae. In all 154 larvae, belonging to both broods in Maryland, have been tested individually in the laboratory. In strong light, although not direct sunshine, the first instar goes toward light; the second, third, and fourth instars respond indifferently to it; the fifth instar goes feebly away from it; and the sixth instar goes either feebly or strongly away from it, depending on the physiological state of the larva. Since first-instar larvae have photopositive eyes, they remain in the open and hunt freely for food, but apparently can perceive it from only a few millimeters. In this case smell seems to be more important than sight. When bands are used as a supplementary control measure we are merely taking advantage of nature's ways by furnishing the fully developed larvae with dark and tight places in which to make cocoons.

We are also making a thorough study of the sense organs of the codling moth and its larvae and are preparing a paper which includes all our information on the tropisms and sense organs of Lepidoptera.

Statement of Mr. E. J. Newcomer:

There are from 30,000 to 40,000 cars of apples shipped annually from the Pacific Northwest. The method of cleaning fruit out there is working out fairly well. Most of the fruit was washed this year and from information furnished by men in the Bureau of Plant Industry station at Wenatchee, and also from experiment station men, we find that washing on the average will remove from 60 to 80% of the spray residue. This means the grower is not free to put on an unlimited amount of spray and expect washing to take the material off. Things went along pretty well this fall until the apples began developing wax. However, they find that by heating the acid solution to a temperature of perhaps 80% they are still able to remove the residue very satisfactorily. It would be better if the fruit could be treated as fast as it is picked, which has not been possible so far. A great many of the shippers were very uncertain as to what to do. Some of the washing machines on the market were practically worthless. Several makes proved to be quite satisfactory. With this year's experience it seems to me the shippers will be in position next year to handle the fruit. One apparent difficulty came up and that was the fruit washed was developing blue mold and various rots in storage or after taking it out of storage. Mr. Fisher, of the Bureau of Plant Industry at Wenatchee, said last summer he believed fruit injury occurring during the washing process was not due to the acid but rather the soluble arsenic. In washing the fruit you make the arsenic soluble. Many of the machines are not equipped to rinse it thoroughly. They are making an effort to rinse the fruit much more thoroughly than they thought necessary at the start. They are also working with formaldehyde and other materials in an attempt to keep the wash bath as sterile as possible. It seems to me the way things are developing out there there should be no difficulty in washing the fruit. With the more successful machines the fruit is carried through on rollers and a spray of acid wash is forced down on it from above, using one-fourth to one-third per cent of acid. It seems to me from the work we have done it is going to be necessary to use a minimum of probably one or two arsenical sprays. We perhaps do not have quite as much a problem as in the East, yet we feel there are other insects than the codling moth which if we stop spraying with an arsenical will become a considerable factor, the fruit tree leaf-roller for example. Some of the other insects would become serious. The question now is whether the lead is not more dangerous than the arsenic. For that reason it seems to me it is desirable to continue the work with other arsenates which would avoid the lead problem. We find that a calyx spray and first cover spray may put more than the British tolerance on the apples. We have had analyses as high as 0.013 on fruit sprayed that way. No spray was put on after June 10 and the fruit was picked the first of October. In 1926 we did a little dusting and got 20 to 25% wormy apples. Most of the dusting was done early in the morning. We were unable to get the control that we did with the liquid. A few growers in the Hood River section are using dust, doing the work at night when the wind is not blowing and using an electric searchlight. They claim success with it.

The substitutes for lead arsenate all gave poorer results than lead arsenate itself. Six applications were made. Lead arsenate 1-50 gave 99% free of worms. Manganese arsenate, zinc arsenite, calcium arsenate, and zinc arsenate gave from 97 to 95% clean fruit; tricalcium arsenate, and barium arsenate gave 94 to 90%; aluminum arsenate 88%; magnesium arsenate, ferric arsenate, and magnesium fluosilicate gave 83 to 80%; sodium fluosilicate gave 74%. Manganese was at the top of the list with the exception of lead arsenate. Results with manganese arsenate were better than those reported by other investigators. This may have been due to variation in the material. The check tree had 40% of wormy fruit. Zinc arsenite burned the fruit severely. We had no injury from any of these materials before September 1, there being little rain before that date. Beginning about that time rain started and injury appeared and by the time the fruit was picked in October injury was noticed in all of the blocks.

The fluosilicates gave really better results in laboratory tests than arsenate of lead and for that reason it strikes me there is a possibility in those. It is possible the materials can be improved and there is also a possibility that we can find something in the way of a sticker to hold it on.

Oil sprays do not give as good results as lead arsenate when used alone, but when combined with lead arsenate, the results are better than with lead arsenate alone, due chiefly to the ovicidal action of the oil However, we can not recommend oil sprays for codling moth control at present, because we often get injury to the fruit or the tree, and until we know more about this factor we can not guarantee that no injury will occur.

Nicotine has been supposed to act as an ovicide. All of the experiments I have made for the past six or eight years showed an egg mortality of only about 25% with nicotine sulphate but I find the eggs will hatch and the larvae will be killed by the nicotine before they have a chance to enter the fruit, and that is where the nicotine is effective. I believe nicotine costs about three times as much as lead arsenate. The growers complained very seriously about it as it makes many of them sick who use it. The nicotine people are doing some work with nicotine and they are confident that a chemical or other material will be found to put with nicotine that will make it effective over a much longer period than now. If that can be done it might be possible to get control of the worms by using less nicotine than is at present the case, which would reduce the expense. If the nicotine is less volatile it should be less disagreeable to the user. Experiments will be made next year in California and at Hood River, Oregon, as well as at Yakima and Wenatchee and we hope to get something out of the same.

Mr. Yothers was not able to find any difference in the different band materials used. He tried some of the bands treated with oil and beta naphthol and did not find any pupae under these bands, indicating that the worms were being killed by the material. A large percentage of the worms were going into the ground at the base of the tree. Mr. Yothers made the suggestion that it might be advantageous to put the bands down instead of putting them up on the trunk. It could be done in some cases and might result in increasing the number of worms captured on the bands. A lot of work was also

done with codling moth baits. Some of the tests we made indicate they would be of some advantage. In 1926 we had a block of 40 or 50 trees baited and the orchard was sprayed by the grower, and we found 20% of the apples wormy outside of the baited block and 10% wormy inside of the block, indicating the baits were helping in controlling the worms. The baits have a very interesting possibility as an indicator and by examining them every day or so you get a very good idea when the codling moth is in the orchard. When the temperature is warm enough the moths are actively laying eggs and are caught in the baits. This gives the grower an indication when to start spraying. Mr. Yothers tried a few experiments with lights this summer and we were rather surprised that we succeeded in catching a number of codling moths. We averaged during the month of August something like 25 to 30 moths per night.

The question of orchard sanitation is important. One of the growers out there tried a little experiment. He had a packing shed in which he stored his old apple boxes. The moths would come to the windows and he killed about 3,700 moths in one season at these windows. In previous years he had left the windows open and the moths escaped.

Statement of Prof. P. J. Parrott:

I have not a great deal to report since Mr. Harman of our department is the one who is devoting his attention to this project. What I have to say relative to the results of our studies accords in a large degree with the reports that have so far been presented by other workers. Control of the codling moth is not nearly the problem in New York as in other areas. We are primarily interested in the cooperative effort because of the interest in spray residue and the apparent need of discovering an efficient insecticide that has neither lead nor arsenic as its chief constituents. We tested the materials sent to us by Dr. Porter but, as just reported by Professor Flint and Professor Dean, we concluded from the season's efforts that none of the materials considered as possible substitutes were any better than lead arsenate or lead arsenate in combination with lime-sulphur, and certainly many of them were distinctly inferior.

The materials tried were calcium arsenate, magnesium arsenate, zinc arsenate, tricalcium arsenate, manganese arsenate, scorodite, and sodium, calcium, and barium fluosilicates. Scorodite and the fluosilicates were very disappointing. We have not been at all enthusiastic with the white oils. One and one-half per cent Volck oil in combination with arsenate of lead, two and one-half pounds to 100 gallons, gave better control of the codling moth than the arsenate of lead alone. However, Greening apples were badly russeted when Volck oil was used either alone or in combination with arsenate of lead or Bordeaux mixture. The oils were toxic to the eggs for about a week after application.

Mr. Harman, who has been carrying on studies in western New York, also worked with baits, conducting this work along lines similar to those of Dr. Peterson. The number of moths caught was very small as compared with infestation of the orchards under observation. Work was also done with light traps. As far as the codling moth is concerned the situation with the lights is just about as that reported for the baits. On the other hand, following the suggestion reported from Oregon and Washington relative to trapping of moths in cold-storage houses, we have obtained significant catches. The significance of the efforts depends upon the importance of cold-storage houses to adjoining orchards. As Dr. Peterson reported, we also observed that the flight of moths in cold storage houses was approximately three weeks later than the period of maximum flight of moths in adjoining orchards.

As regards spray residue we have not had very much trouble. Our chemist, Mr. Streeter, is working on that problem. He has made examinations of apples in our different sprayed plats and commercial orchards in the vicinity of the experiment station, and I do not believe that with spraying as we do now, limiting our applications to the first brood, we are going to experience very much trouble. Nevertheless, we shall need to be on our guard in order that apple growers shall not fall into careless habits.

Statement of Prof. J. J. Davis:

Our codling-moth program was started this past spring (1927) and was divided into two phases, one an attempt to demonstrate the possibility of thoroughly cleaning up a heavy codling-moth infestation in certain sections of southern Indiana, this work being handled largely by the Horticultural Department. It clearly demonstrated the possibility of cleaning up bad codling-moth infestations by intensive methods. The other phase of the work, which was handled by the Entomology Department, was entirely investigational. The work was conducted in Lawrence County and we had one full-time man on that work, Mr. L. F. Steiner. He was assisted for three months during the summer by Mr. Carl Mohr. We established an insectary for the work in one of the heavily infested areas of southern Indiana. The work included intensive larval and adult behavior studies as a basis for the development of additional and supplementary control measures or to increase the efficiency of the present control measures. Inasmuch as this was our first year of codling-moth investigation, we felt we should cover the situation pretty generally, that is, take on a large number of projects. This for various reasons. In the first place we wanted to get something we could give to the growers immediately. In the second place we felt a complete survey of the various problems would enable us to better develop our work in the future. For that reason we undertook a larger number of investigations than we could ordinarily consider.

Bait traps.- We had some 60 different essential oils and apple odors tested out by the bait-pan method, the same type of bait pan mentioned by Mr. Newcomer. We wanted to find out the type of pan most efficient, the position in the orchard, the height, the type of baits, etc. In those experiments we found, as did Mr. Newcomer, that the baits in the upper parts of the tree, especially in the extreme upper parts, were by far

more attractive. Exposure to open conditions and absence of foliage about the bait pans was about as important as height in the tree. We found that while ferments attracted the moths and certain odors also attracted them, a combination of a ferment and odor was by far the most efficient. None of the baits were sufficiently effective to make recommendations, but the combined ferment and odor seemed most promising. We found that growing apples were more attractive to the moths than apples which were freshly cut off and tied to the tree, showing that there might be some vaporization of the odor or other material while the apple is growing. Over 70% of the moths collected at bait traps were females and 95% of these were gravid females. The number of beneficial insects taken at the baits was negligible and there was quite a large number of other insects; a great many cutworm moths, and in 28 of the geraniol-molasses ferment baits there were over 10,000 green June beetles. They were not sufficiently attractive to the codling moth to enable us to make recommendations, but, as has been reported in several cases here, we feel the baits are useful to determine the time for spraying, either by the orchardist or by the experimenter. We are going ahead with bait traps next year, especially the one which gave best results, namely the molasses-geraniol bait. We tried out light traps, not in a very definite way, and of all the lights tested one moth was found and it may have gotten in by mistake. Another phase of the tropism studies is that of repellents, studying these under laboratory conditions. Some interesting information was secured. We used a repellent material, Milkol, a compound used in blossom sprays for repelling bees. Counts at picking time showed partial effectiveness in preventing egg deposition. The results were of course not at all conclusive, but were indicative and we feel more work can be done along this particular line. With the work we expect to do with the olfactometer tests this winter, we hope to be in better position in the spring to make suggestions for repellents for experimental field work. We tested out quite a number of olfactometers.

Banding.- Quite a number of bands were tested to determine materials best adapted for orchard use, the width and height on the trunk, etc. We used tarred paper bands and corrugated cardboard with a double face and with single face, burlap three-ply, crepe paper such as you find in sacks of Niagara dust, and another material known as Rexford paper, a sample of which I have here. Most of you are probably familiar with it, which consists of paper on one side and burlap on the other, with an adhesive of tarred material between which makes it practically impervious to light. The results obtained show that the corrugated cardboard, both double and single faced, gave best results; the next was this Rexford cloth. The third material was the burlap, 3-ply; fourth, the tarred paper and the crepe paper, which were equally efficient. Inasmuch as the corrugated cardboard must be replaced each time it is examined and is very difficult to examine, it could not be recommended over the Rexford paper which came in a little behind it in number of larvae collected, especially since this material is reasonably cheap and can be used throughout the season. The price they gave me, in a letter just received, in four-inch width rolls is $1.35 per 100 yards. It would mean 1 -1/3cts. a yard and figuring on a yard to the tree -- certainly not more than that -- it costs 1-1/3 cts. per tree for the material. We tested out a number of things, namely, Volck and other oils and also tested out pyrethrum oil, Derrisol and derris alone, as well as other materials. We did not test

out beta naphthol. While we could get around 50 to 60% kill, we could not get sufficiently high kill to warrant a recommendation for any material to treat the bands.

Insect behavior.- Quite a number of olfactometers were tested. The female moths were attracted to growing apples, but materially less to the ripe apple or other apples picked and hung on the tree. There is a definite reaction there. We also made observations on the reaction of the moths to wind velocities. Screens were placed between orchards in an attempt to find out whether or not the moths migrated from one orchard to another. Only two moths were collected from the screens, indicating a migration of possibly 1/2 mile distance. We did not carry on laboratory work on the behavior of the larvae, but we have some interesting field observations on the habits of the larvae. For example, newly hatched larvae were found to crawl 10 feet in their attempt to find an apple. We also found that larvae in apples buried 6 inches under unpacked soil could come to the surface and will remain alive as long as the apples remain solid. Rather interesting observations were made by Mr. Steiner regarding the attraction of the trees to the larvae. He found that during the day time the larvae had no difficulty in working towards the trunk of the tree, perhaps 90% of them finding the trunk. On the other hand when he turned the larvae loose at night they were unable to find the tree trunk and crawled about aimlessly. He found that where they came in contact with cornstalks they would usually accept such material as places for cocooning, although in some cases they crawled long distances in their search.

Packing-shed sanitation.- In order to determine with accuracy the importance of packing-shed sanitation the shed at the Purdue farm at Bedford was made tight. At the two windows at each end of the building near by 6,000 moths were collected and Steiner estimated he lost possibly half as many more. Mr. Troth at Mitchell, who had a serious infestation in 1926, estimates that he prevented the escape of from 25,000 to 35,000 moths by screening his shed. These observations have enabled us to convince the fruit growers of the importance of taking care of the packing shed.

Orchard sanitation.- Observations showed that soil and light debris, such as leaves, are not important carriers of the larvae. Any small rough-barked shrub, such as Symphoricarpos were frequently selected by the larvae for cocooning as were also cornstalks, pieces of wood, dead limbs on the tree as well as on the ground, short weed stems, and cloth materials.

Nonarsenical sprays.- A new oil base contact insecticide was substituted for the arsenate of lead spray for the second brood, using two typical trees in the experimental orchard. Three applications of this spray gave better control and more sound fruit than an arsenate of lead spray and two dusts, and at the same time avoided the arsenical residue problem. The results were promising and will be followed up in 1928 with larger tests.

One of the interesting pieces of work was with the parasite Trichogramma minutum. We received a letter from Mr. Flanders of the Walnut Growers Association in California, asking us if we cared to have material for experimental work. As a result of our reply, they sent us 170,000 parasitized eggs with the result that as high as 75% of the eggs of the codling moth on some of the test trees became parasitized with Trichogramma in comparison with about 40% of eggs in other near-by orchards which were naturally infested. It was late in the season. Parasitism always comes on too late in the season to be of any particular value, but the results showed that there was a possibility of utilizing Trichogramma parasites if they could be obtained early in the season. As a result of these experiments we are at the present time working to develop a large number of these parasites for introduction early in the season. We have one experiment under way in which we are breeding the Angoumois grain moth, using similar methods to those employed in California, and hope to have a sufficient number of parasites to test out in a practical way in an entire orchard next season. I think the parasite proposition offers some interesting results. For one reason or another the Trichogramma does not winter over in sufficient numbers to be numerous early in the season.

Future plans.- As to plans for the future, I have indicated a few of these. This winter Mr. Steiner is expecting to carry on intensive indoor insect behavior studies. He has a large number of codling moths in storage and expects to be able to have them issue some time this month. The Trichogramma parasite rearing work will also be continued. For next season we plan to continue our bait experiments, not with a large number of materials but with the materials which seemed to be best during the past season, in an effort to determine their possible utilization and to determine their value in timing sprays. It is rather interesting to note that while on the West Coast in the arid regions rather good results were obtained with bait traps, we certainly did not get very promising results in Indiana. It brings up the point that what we find on the West Coast in the arid regions may not be applicable under our Central-West conditions. I recall a similar case in connection with the onion maggot, where in moist areas the poison bait was not effective, while in dry areas, or at least areas dry in the spring of the year when the baits were used, they proved to be very effective. The onion flies were attracted to moisture. We will continue our olfactometer tests with repellents this winter and also continue our banding work. There are a large number of miscellaneous studies that Mr. Steiner has made that I can not report at this time. The other things to be considered in our 1928 studies include orchard sanitation, spray tests, etc. The parasite work will be continued as in the past. That, I think, Dr. Quaintance, is a brief summary of the work we have done in Indiana the past season.

Statement of Prof. J. S. Houser:

Inquiry has been made as to the method of accounting for the total larval population on an apple tree. When Professor Parrott was entomologist at the Ohio Station in 1903, he started a study of that sort. After a lapse of twenty-four years, we again took it up this year because it did

seem to us, in the light of increasing interest in the codling moth behavior, that we might glean something from that method. We put beneath the tree a sheet entirely around the trunk of the tree and extended it out to the reach of the branches; then we put six-inch boards in an upright position around the edge of the sheet and covered the inside of the boards with tanglefoot; then on the trunk of the tree we put three bands, one of burlap some 6 or 8 inches high, and then a band of tanglefoot, and then another band of burlap. We had hoped by that method to account for the larval population in the fruit, but by that method the first year we were only able to account for about 25% of the larvae as measured by the number of wormy apples on the tree. Of course it may be that some of these apples were inhabited by larvae, and the figures may not be a true condition of the larval population of the tree. We were only able to account for 25% of the larvae on the tree, which were distributed as follows: The number of worms we dealt with was 720. Of that number 399 were on the sheet. The apparatus was examined each day about 6.30 or 7.00 o'clock in the morning. Worms on the lower branch 34, worms on the upper branch 53, worms in the tanglefoot 33, worms on apples after they had fallen on the sheet 201. In any work of this kind you will encounter other biological difficulties. You will find if you attempt to repeat an experiment of this sort that other agencies come in to interfere, and we think one of the important interfering agencies is birds that visit the tree and possibly predacious insects that may visit the tree or the sheet after the larvae are attempting to make their way towards the tree. We found there was general migration of the larvae towards the trunk of the tree. The work this year was on two trees, a sheet under one, and under the other we had no sheet but had the boards covered with tanglefoot within reach of the branches. We recovered, strange to say, almost as many worms from the tree under which we had no sheet as we did from the tree under which there was a sheet. However, this year the work was started a little earlier in the season and that accounts for the partial failure of the work twenty-four years ago. This year we got 70% of the larval population of the tree as measured by the number of wormy apples yielded by the tree. We think the work has some promise and will continue it next year. I think we will discard the use of the cloth sheet.

Aside from the biologic phase of the investigations we too have done banding with the results much similar to those already reported.

We had this year about 58 sprayed blocks located at Delaware, Ohio, and some at Marietta. The Marietta work was done in conjunction with the Crop Protection Institute, and was primarily for testing the value of some of the new oils developed through fellowship supported by the Standard Oil Company of Indiana, Mr. Cleveland cooperating with us. Also in the Marietta tests we had under observations plots sprayed with some of the new materials sent out by the Bureau and I will report on three of these: We had an arsenate of lead plot in which we got 2% side worms, 11% stings, and 31% curculio. A plot sprayed with tricalcium arsenate was inferior and we got 6% side worms and 20% stings. The plot sprayed with zinc arsenate gave 3% wormy fruit from side injury, 16% stings and 27% curculio. Scorodite, which was quite a failure, gave us 28% worms, 23% side worms, 13% stings, and 45% curculio. There was no injury in any of these plots but we have used 3-1/2 pounds of hydrated lime to each 50 gallons of spray mixture. It gave the fruit a better finish than on the arsenate of lead plot.

The outstanding result at Delaware, Ohio, is the excellent accounting that manganese arsenate gave for itself. Using manganese arsenate, 1-1/4 to 50 gal. of lime-sulphur, the dropped fruit was 19% wormy and the picked fruit 3.6%. A stronger dosage of manganese arsenate, 2 to 50, gave dropped fruit 6.5% wormy and of the picked fruit 10%. Comparing these figures with two arsenate of lead plots, one of which was adjoining our dust plots, the arsenate of lead plot gave 19% wormy dropped fruit and 4.5% wormy of the picked fruit, and another adjoining plot gave 3% wormy of the dropped fruit and 1% wormy of the picked fruit. Apple scab completely obliterated the blocks in our check plots.

The season's work has brought out one very significant thing in Ohio and that is the utter failure of dust programs for controlling scab and insect pests in orchards. We have had forced on us some very vigorous dust selling programs in Ohio and had the dust people put on spray service for us. They sold a lot of dusts and a lot of dusting was done. A few orchardists were using dusts because they were easier to apply. This year they have been pretty badly stung, going back to their sprays saying "never again for me."

Statement of Dr. Charles H. Richardson:

Our contribution here in Washington to the codling-moth program may be classed under two heads. Beginning last spring we started work on substitutes for arsenicals. It was decided at that time to get as far away from arsenic as possible and it looked as though the best proposition would be to make a survey of the organic compounds, and this we did. Dr. Campbell came in about the first of June, and of course it took him some little time to get apparatus and insects together for this work. He has been able, however, to get a number of leads, and Dr. Quaintance will, I am sure, ask him later on to give his results to date.

For a number of years we have been working on contact insecticides in the Bureau in cooperation with the Bureau of Chemistry, particularly on nicotine-like compounds. As reported previously, our work with dipyridyls has been continued in the hope of finding what particular compound or compounds in the so-called dipyridyl oil are responsible for the remarkably high toxicity of this mixture. The chemists have been working on this particular part of the problem and their studies have reached the point where we can almost say that the insecticide instead of being dipyridil, as previously thought, is a combination of pyridine and piperidine. The difficulty in determining this at first was due to difficulty in the isolation and analysis of the compounds. More recently we have been led partially from work done at the Rothamstead Experiment Station, England, to take up a new series of compounds falling within the group in which we have been working, namely, the benzylpyridines. We find these compounds, as they have been found in England, to be quite toxic and they offer another interesting group of compounds for insecticidal studies. We are experimenting with several of them at the present time.

Since we are working on nicotine-like compounds we have considered it advisable to continue along with these studies experiments with nicotine itself. During the past summer we have worked on nicotine and have used mosquito larvae as test insects. You will recall the controversy which has been going on for some time in regard to the toxicity of nicotine and nicotine sulphate, and I think it is rather generally held that in order to get the best results from nicotine sulphate it is necessary to render the nicotine volatile. We wondered whether this is the only explanation of the toxicity of nicotine in comparison with nicotine sulphate; that is, whether toxicity in this case is chiefly related to volatility. We have used mosquito larvae because under such conditions we can maintain a constant concentration. One can easily maintain a constant temperature and, of course, humidity is constant. We made a great number of experiments during the past summer and find that nicotine is more toxic than nicotine sulphate in solution, that is, when the insect larva is completely submerged; in fact the ratio of toxicity of nicotine to nicotine sulphate at any concentration used, on the basis of time required to kill, is about 1 to 6. We further find that as we decrease the PH in passing from an alkaline to an acid solution we get a progressive decrease in toxicity. Nicotine at PH 5 is the nicotine sulphate which we ordinarily use. Nicotine is diacid base and takes on two sulphate groups; at PH 5 about 99% of the nicotine in solution is completely ionized, that is, broken up or separated into nicotine ions, whereas at PH values higher in the scale, at say from 8.5 to 9.4, less than 20% of the nicotine in solution is in the form of ions and more than 80% of it is in the form of molecules. It has been found with other compounds and other organisms rather recently, although the studies indicative of this result go back for some years, that compounds are apt to be more toxic whenever they enter the organism as unassociated molecules, and when such compounds are converted into the ionic condition there is a decrease in toxicity. Our results agree with this theory very completely. Any solution of nicotine base which entomologists would be apt to use is already largely undissociated. Further suppression of ionization by the addition of another base will not appreciably increase toxicity because 85 to 90% of the nicotine is already in the molecular condition.

The results we have secured perhaps have no immediate practical application but they tend to explain at least why nicotine is more toxic than nicotine sulphate, not only in the form of a contact spray but also when an insect is completely submerged in the solution.

Statement of Dr. F. L. Campbell:

As Dr. Richardson has told you, this work has been under way only since the first part of June and considerable preparation was necessary. You will therefore understand why so little work apparently has been done. We thought it best rather than to work on the codling moth to use a laboratory insect which we could get as nearly all year around as possible. I hope next year to be using either grasshoppers, cockroaches, or meal worms most exclusively. This work should give us information of a general nature. Of course it may possibly be applicable to the codling moth. This summer the first organic compounds which became available happened to be a series of dyes and the only insect which I could get at that time in large

numbers was the silkworm. Consequently I studied the relative toxicity of these dyes to the silkworm. Solutions of 24 dyes representing all the chemical groups were administered to individual silkworms either by mouth or by injection. We found that basic dyes only showed any high degree of toxicity. Acid dyes were scarcely toxic at all. Of the basic dyes used we found that malachite green is most toxic. Its toxicity is slightly greater than that of arsenic with the same insect. Next came safranin bluish, brilliant green, and crystal violet. All of the dyes were water soluble and were not all suitable for application in their present form but it happens that basic dyes are very readily absorbed by either charcoal or clay and I am hopeful that it may be possible to apply these dyes in that way. Experiments are being conducted at the present time on the absorption of these dyes and next spring and summer I will carry out feeding tests. A considerable series of organic compounds other than dyes will be tested as soon as the insects are available. We are also beginning work on the toxicity of lead in lead arsenate. There seems to be considerable interest in what part the lead plays in the toxicity of lead arsenate. We hope to find out something about the distribution and excretion of lead from lead arsenate in the insect.

Statement of Mr. E. H. Siegler:

Banding work.- A number of men have been experimenting with the self-acting chemically treated bands the past season. On the whole the results obtained appear promising but are not conclusive since our experience covers but one full season. We attempted to find out what banding material was the most congenial to the larvae, but, as Professor Flint has stated, the numerical variation in the total larvae per tree is often so great that it is impossible to gauge accurately which type of band harbors the greatest number of larvae.

In the attempt to find the best insecticide, several chemicals were applied to the bands. A series of soluble arsenates and insoluble arsenates as well as several fluosilicates and a fluoride were tested. None of these was effective to a satisfactory degree. Lubricating oil (red engine type), white mineral oil, and a white mineral oil emulsion were tested. The oils were effective for a time but their period of effectiveness was not as long as would be desirable in commercial usage.

The best net results were obtained through the use of a combination of beta-naphthol (technical grade) and lubricating oil, in the proportion of 1 pound of the former to 1-1/3 pints of the latter. This mixture was applied to the band by means of a sponge. This mixture was used in connection with different types of cloth and paper bands. In New Jersey, where Mr. Brown carried out the tests, the rainfall amounted to about 22 inches during the period the bands were in operation. Under these conditions, the insecticide was more readily washed away from the cloth bands than from the paper bands. Of all the bands tested, crepe paper treated with beta-naphthol and oil gave the best results. Our observations lead us to believe that less washing took place on the crepe paper bands than on any other type of band tested.

Mr. Yetter, of the Colorado State Experiment Station, conducted tests at Grand Junction, Colo. Only 5 inches of rain fell during the period when the bands were exposed. His results indicate that this amount of rain did not remove the mixture of beta-naphthol and oil from cheese-cloth bands to the point where the insecticide would become ineffective. However, it should be stated that he retreated the bands and as a result a direct comparison between the work in New Jersey and Colorado can not be made. It may be of interest to know that the results of Mr. Yetter's tests show an average kill of over 300 larvae per tree. The trees had been sprayed with arsenate of lead throughout the season.

An improved method of applying beta-naphthol and oil to the bands has been devised recently. By heating the oil to a point slightly above the melting point of beta-naphthol a homogeneous solution results. The band may be treated readily by dipping it into the solution.

Of the bands tested, the crepe paper band is the least expensive. The cost of the band itself (3 feet in length by 4 inches in width) is about 1/2 cent. The cost of beta-naphthol and oil treatment of a band of this size is about 1 cent to 1-1/4 cents.

Mr. Brown has made what may prove to be an observation of practical value in connection with the part the edges of a band may possibly play in enticing the larvae into the band. In the case of bands, such as burlap, having wide edges, the larvae are more likely to hesitate when they come in contact with the edge and to sense a favorable cocooning place than they are when they reach the edge of a thin paper band. With this hypothesis in mind, we plan to fold the edges of the crepe paper band in future work with the hope that a larger number of larvae may be influenced to cocoon beneath this type of band.

No apparent injury resulted from any of the chemicals tested, although small blister-like projections were present under most of the bands. This condition is probably due to the fact that evaporation does not take place normally under the bands. However, on removal of the bands, the blister-like growths become powdery and slough off. The inner bark seems normal.

Until it has been ascertained by further experiments that no injury to the trees will result through the use of chemically treated bands, we wish to emphasize that it would be desirable to conduct tests on a small scale.

Entomologists who wish to test the chemically treated bands may obtain directions for preparing the bands by addressing E. H. Siegler, Silver Spring, Maryland.

Statement of Dr. W. S. Hough:

Part of our work of the past season was a continuation of studies of three previous years on spraying and spraying equipment. It is a well known fact that the upper half of an apple tree is rarely sprayed as thoroughly as the lower part. The aim was to obtain nozzles and nozzle combinations which would enable one to spray all parts of the tree alike. Nozzles with six holes in the whirl disc have been selected. By combining them in simply designed heads the desired results have been obtained. Some of the fruit growers in our section have been using the noxxle heads for the past three seasons, and this coming season a spray pump company will place them on the market. Codling moth control in Virginia is a matter of spraying all parts of the tree alike and thoroughly. At any rate, I do not know of a single orchard, where the spraying has been thorough, that the codling moth has not been controlled by sprays applied for the first brood alone.

The other part of our work pertained to a biological investigation of codling moth strains and their tolerance to arsenic. This investigation began last spring and has proceeded far enough already to yield some illuminating results.

Statement of Dr. T. J. Headlee:

We have been at this codling moth business a good while. There is not much use in going back over the old experiences but we might draw some conclusions from the past few years on various points. On the question of the relative value of the various treatments, I think we can say that banding as we have seen it with about 50,000 bands is an adjunct in codling-moth control. I may illustrate this by giving you two examples. One man scraped his trees thoroughly and banded them with burlap. This man banded his trees thoroughly and looked after his bands and sprayed when he felt like it. He got an average of 5 worm-holes per apple. In another case, bearing on the orchard sanitation question, another man had an open shed in which he had something like 28,000 baskets stored. He had no method of keeping the moths from getting out and the shed was not over 75 feet from the edge of the orchard. He sprayed the first 10 rows next to the shed very thoroughly and kept it coated so that it looked as if they had been turned upside down and whitewashed well. He had 30% clean fruit, again showing the relative efficiency of spraying and one type of orchard sanitation. An enormous number of moths escaped from the packing sheds and from storage houses. I do not think there is any question about the amount of moths coming from packing sheds. Enormous numbers of codling moths spin up in pruning scars and spin up in limbs that have been cankered so that they look almost like a hairbrush, showing these places are important ones for spinning up. We find no difficulty and no reason for bands or banding in orchards that are fairly well isolated and composed of young trees. I have one orchard in mind of 276 acres. The trees are from twelve to thirteen years old and these are sprayed only for the first brood. This man had from 95 to 97% of the fruit at picking time absolutely clear and clean. To my mind the banding proposition is simply an effort to reduce the codling moth situation on trees that are old and have lots of pruning scars.

The question of the kind of spraying is a matter of enormous importance. There is one orchard of something like 100 acres, the owner of which has never been able to secure the under-spray system based on the data offered by Dr. Hough, and that man was this year able to get an increase in clean fruit not exceeding 15%, while his neighbors were getting from 25 to 30% increase in clean fruit simply, so far as I could see, because they did follow the spray system. This system means that you get a coating of the fruit and foliage on all sides and whenever worms try to make entry, whether they try to feed on the foliage or try to enter the apple, they meet the barier of poison and are destroyed. I regard the under-spray system involving complete treatment on all sides of the fruit and foliage during the period of injury of worms of the first brood and second brood as of prime importance in fighting the codling moth. The amount of arsenic applied is also important. Some years ago we found in a study of this kind that 1-1/2 pounds per 50 gallons of powdered lead, and more than 2 pounds, was not any better than 2 pounds. Another element of extreme importance is the time of application.

Now as regards the value of the blossom-fall spray, I would like to say that for three years now we have had blocks without any blossom-fall spray and those blocks were carefully sprayed during the injury period and the amount of injury at picking time did not differ in any material sense in any of the blocks. The blossom-fall spray is a thing that can be eliminated when you practice thorough sideworm sprays. It may not be true at all for the western fruit and it may very well be that the western apple has a more open calyx. I remember some years ago the furor concerning filling the calyx cup which was brought very strongly out in the West and Northwest and apparently there was more arsenic put in that calyx cup out there than we could possibly get in here. As to the matter of timing, I think there are certain definite ways of timing adequately. In the first place, we have had for some years a large series of experiments which could be correlated with temperatures and we applied the results in 1927 to our work in Glassboro, involving some 1,500 acres.

Codling-moth bait pans are also a very excellent indicator to my mind of codling moth activity in the orchard, as has been said by others here. We use in our bait pans the molasses bait. This year the bait pans got something like 1,680 moths of the first brood and something over 800 moths of the second brood.

We propose to put out the coming year about 25 or 30 stations in different parts of the State to determine and make recommendations as to the period when spraying is to be carried on. We feel reasonably sure that where the infestation of fruit on unsprayed trees does not exceed 50% we can control the codling moth by the well timing of a small number of sprays. But where the infestation of unsprayed fruit runs something like 50% or better, we must cover the period during the time the first brood is trying to enter.

As to the nature of the cover spray, we believe from a number of years' experience the best cover spray is the film-coat cover spray. The more perfect a film-coat can be made the more complete will be the resultant

control. I speak of the film-coat of the fruit and foliage. We find that casein is apparently the best thing we have been able to lay our hands on -- either casein and lime or powdered sweet skim milk running at least 25% casein content. We found relative to the spray residue that where our cover sprays exceeded three in the season of 1927, the amount of residue is beyond the 0.01 grain of arsenic per pound of fruit. Where your cover sprays under these present conditions with heavy rainfall run three you are approaching the 0.01 condition. Where only two cover sprays are used you are merely in the clear on that basis. The question is whether we can control the codling moth where it is serious with even three cover sprays for the first brood. I think there are situations where it is serious enough with us where we will probably not be able to do it. I should say at this point that in northern New Jersey and central New Jersey, including Monmouth County, we will have no trouble in controlling the insect by handling the first brood only. It is only when we get into southern New Jersey in the most favorable quarters, such as Hamilton and Glassboro, that we have reason to anticipate trouble.

We had some experience with washing and find very much the same sort of experience that Mr. Newcomer mentioned from the Northwest. We find the washing method is comparatively easy where the fruit is picked but is much more difficult after it goes into storage when something of a waxy nature makes its appearance on the apple after which the removal is much more difficult; but by heating the acid, possibly increasing the strength a little, we seem to be able to remove it.

Statement of Dr. B. A. Porter:

Our work in Indiana last season was almost entirely with possible substitutes for arsenate of lead. The greater part of the work was done in the laboratory, following substantially the technique developed by Newcomer and by Smith. We like this method of attack for certain phases of codling moth control, particularly for the preliminary stages in the development of new materials. One important advantage is its flexibility, making it possible to repeat tests, vary the dosage, and follow up promising leads at once, rather than wait for another season, as is necessary in field work. Another advantage is the elimination of irregularity in infestation, a factor which often causes erroneous conclusions in field tests. Also, a much larger number of materials and combinations can be tested in a given season than is possible in the field.

We also discovered other important factors. We found that the percentage of entrances in a given lot is very irregular, and a similar condition appeared in the raw data which Smith published. This means that rather large numbers of worms are needed before any close comparisons are possible.

The handling of laboratory tests of this nature is a full-time job for at least one man. The worms must be transferred as soon as possible after hatching, which means frequent examination of the cages used. For efficient work, there should be a sufficient supply of material to keep a man busy full time, since he must be on hand at frequent intervals to transfer the worms which have hatched.

The materials we used were mostly those which have already been mentioned here. Our conclusions are substantially the same as others have reported. Arsenate of lead is still the best by far, although some of the arsenicals other than lead were fairly good. Among the nonarsenicals, the most promising materials seem to be the fluosilicates, particularly barium fluosilicate, and cryolite. Health officials also consider barium a dangerous poison, however, so we may be unable to use it even if effective. Cryolite seems to be fairly good in the laboratory. Barium fluosilicate has given much poorer results in the field than in the laboratory. If the difference is due to a chemical reaction which takes place on exposure to air, possibly we can do nothing about it. If it is a matter of adhesiveness, which we strongly suspect, we may be able to correct it. Some of the materials were also tested in the field on a small scale. While the results were fairly good, no material was as good as lead arsenate. We secured very little information on foliage reactions because of the peculiar season. We had a great deal of injury to foliage on the particular variety used, but very little of it could be definitely attributed to the insecticide used.

I might mention also that the Purdue Department of Horticulture has done considerable work with spray residue removal by the use of a simple homemade outfit, following suggestions which came from the Federal Bureau of Plant Industry. The residue is removed by dipping, making unnecessary the use of expensive machinery for spraying the acid on the fruit. It appears possible to reduce the arsenic 50% or more by the use of this outfit, which need cost not more than $50.00.

Statement of G. A. Runner:

Our difficulty in using arsenical compounds on grapes is that applications made against the second brood of the grape berry moth are apt to leave excessive arsenical residue on the ripened fruit.

In connection with tests of various arsenicals on grapes, we have for two seasons carried on some experiments on apples, using the same dosages of lead arsenate commonly used on grapes and we have had no difficulty at all with excessive residue. This season, in one orchard, in a block of Grimes Golden, we applied four sprays, the last on August 1. An analysis of samples of ripened fruit made by the Food, Drug and Insecticide Administration at Cincinnati showed only a trace of arsenic. I believe apple growers in northern Ohio will have no serious trouble from the arsenic standpoint, by using present spraying schedules.

With grapes, the situation is entirely different. In one instance, one application of lead arsenate at the rate of 1-1/4 lbs to 50 gallons of mixture, made July 18, gave an excess of arsenical residue. We use resin fish oil as a spreader and sticker in mixtures for grape spraying. In all, about 40 samples of grapes from our experimental vineyards were analyzed by the Food, Drug and Insecticide Administration this season. In most instances applications of any of the arsenical compounds tested resulted in a rather heavy and perhaps dangerous residue remaining on the grapes if the last spray was applied after July 20th. It seems probable that if the 0.01

arsenic ruling is enforced, spraying with arsenicals must be limited to work against the first brood of berry worms until materials are found which can safely be used for later sprays. It seems impossible, in seasons when development of the berry moth is late, to secure satisfactory control by spraying against the first brood only, if the infestation is at all heavy. For instance, this season a great many, in fact most, of the eggs of the second brood were deposited during the last week in August. In rainy seasons, and when the second brood of worms appears late, we can hardly expect satisfactory results from sprays applied far in advance of hatching. There is of course the possibility of securing better results by more thorough work against the first brood, especially if supplemental control measures are employed which will reduce the overwintering brood to the minimum. I have not received complete reports of the arsenic survey of grapes made by the Food and Drug Administration this season. However, from the data at hand, and from results of the survey made last year, it would seem that we may secure fair control of the berry moth during a normal season by slight changes in spraying practices, and at the same time keep within reasonable distance from the present arsenic tolerance of 0.025 gr. per pound of fruit. If the proposed limit of 0.01 gr. per pound is put into effect next season, grape growers will, I believe, either have to discontinue spraying against the second brood of berry worms or resort to the troublesome and perhaps expensive method of washing the grapes with arsenic-solvent solutions after the fruit is harvested.

APPENDIX

Several collaborators were unfortunately not able to be present at the Washington conference; some of them, however, had earlier furnished reports on their work for the season. These reports are presented herewith and will add much to the value of these minutes.

Report of the Oregon Agricultural College Experiment Station,
James T. Jardine, Director, Corvallis, Oregon:

Progress Report on the Spray Residue and Codling Moth Problem.

Insecticide control

Present status of spray residue- Results of analyses of fruit sprayed according to present recommended spray schedules.

During the last two years hundreds of samples of fruit from various parts of Oregon have been analyzed. The results show that in most districts in Oregon growers who follow the spray schedules harvest fruit having a residue above the world tolerance. If the spray schedules are not followed wormy fruit results.

Results of experiments to avoid excessive spray

(a) Shorter schedules, with the use of later sprays curtailed -

Shortened schedules are not safe in Oregon and perhaps throughout the Northwest during most seasons. Many growers at Hood River, Medford, and other parts of Oregon have tried shortened schedules this season with disastrous results. At the Central Station, where the last cover spray was omitted, As $_2O_3$ at picking time was less than 0.015 grain per pound. Heavy rains preceded picking. Worm control was not as good as on the plots where the complete spray schedule was followed.

(b) Substitution of dusting for spraying-

(1) The experimental tests carried on at the Central Station this season averaged about 83% clean fruit in the dusted plots compared with about 88% clean fruit in the sprayed plots and 7% clean fruit in the check plots. The weather this season in this section of the Willamette Valley was unusually favorable for dusting. In all cases except the fruit on those branches receiving the heavy first cloud of dust on starting the machine, the As_2O_3 residue at picking time was under the world tolerance. Wiping readily brought the fruit under the tolerance.

In the Hood River Valley a few growers report favorable worm control and the reaching of a 0.01 per cent tolerance by wiping where dust was used after the first cover spray; others failed to obtain satisfactory worm control. Previous experiments and experience in the Hood River Valley indicate that dusting is not effective in the hands of a large percentage of growers.

In the Medford district the substitution of dust for liquid spray has not proved satisfactory because of the general windy weather.

(2) At the Central Station, where dusting was substituted for the last two cover sprays, no appreciable difference in worm control was noted. All the apples were under the American tolerance. Heavy rains preceded picking. The 0.01 tolerance was reached by wiping.

(c) Use of contact sprays in place of lead arsenate -

1. Oil sprays - 1-1/2 to 2 gals. to 100 gallons spray.

Worm control

(a) Oil sprays, when added to the arsenate of lead program, very materially increased worm control.

(b) When used alone the oils gave unsatisfactory control, even when following a calyx spray of lead arsenate.

Reduction of residue

The combined oil-arsenate of lead spray not only did not reduce the residue but it greatly lowered the efficiency of acid washing. High acid concentration failed to remove residue from fruit sprayed with both oil and lead arsenate in some cases.

Effect on foliage and fruit.

Oil sprays, including the red engine type and the white or so-called summer oils, have caused serious injury to the fruit of certain varieties of apples. Last season (1926) this injury occurred, especially at the calyx end on green and yellow varieties. Red varieties in some cases last season (1926) were reported to develop unnatural or uneven coloring.

This season (1927) at Southern Branch Experiment Station all the various oils used caused severe injury on Newton apples. At Corvallis, of the four light oils used, only one (Cooperative Experimental No. 4) caused slight injury only on Newton apples.

Experience and experiments at Medford indicate that oil may have a place in the spray schedule for pears especially as a combination for codling moth and red spider control. No apparent injury has developed on pears.

Nicotine sulphate in the last two cover sprays in combination with lead arsenate did not noticeably reduce worm damage at Hood River. When substituted for the last cover spray at Corvallis, control was not as good as on plots where lead arsenate was used in the last cover spray.

(d) Substitutes for lead arsenate -

Calcium arsenate (same dosage as lead arsenate) gave approximately the same worm control as lead arsenate at Hood River and Corvallis. No injury was observed at Corvallis but at Hood River considerable foliage injury during late summer developed. At Corvallis extensive tests of calcium arsenate dust gave as good control as did lead arsenate dust. The As_2O_3 residue is found to be about the same as when lead arsenate is used.

Manganese arsenate (same dosage as lead arsenate) with spreader gave approximately the same worm control as lead arsenate at Corvallis. At Southern Branch and Hood River Stations it was used without a "spreader." Poorer control resulted at both stations. No apparent injury resulted from its use. The As_2O_3 residue is found to be about the same as when lead arsenate is used.

Calcium and sodium fluosilicates gave no worm control.

Results of experiments with the removal of arsenical spray residue

(a) Washing with HCl appears to be the most reliable method. HCl cleans even the most heavily sprayed fruit. In some cases difficulty arises from the formation of wax on overripe fruit. As a remedy for this condition processing early after picking will assist. Also difficulty arises from the presence of dust, particularly in the stem and calyx ends. The addition of Bordeaux in the summer sprays or of lime, 3 pounds to 200 gallons, in the last spray, will speed up residue removal. When properly done, using the flotation, jet, or splash machines, no bad effects have resulted. The cost, under this year's conditions, ranges from 3 to 8 cents per box. With the elimination of the experimental features of the process thus far encountered the cost should be reduced so as not to exceed 2 to 4 cents.

(b) Mechanical wiping.

Not reliable.

Control by means other than spraying

Banding: No experimental work. Banding has been tried, however, on a rather large scale in the Rogue River Valley and those growers who took care of the bands report real benefit. Too many growers, however, neglected them at critical periods.

Cider bait traps have been tried with the result that thousands of moths have been caught, but whether of practical value in moth control is not known.

Artificial use of parasites: No work along this line has been undertaken. A parasite of the larva was reared from material gathered in the region of Corvallis. 40 per cent of about 500 larvae collected in the field, under bark, were infested.

Biological studies - No new information

Henry Hartman
R. H. Robinson
Leroy Childs
Bob Norris
B. G. Thompson
Don C. Mote

Report of Mr. Chas. H. Alden of the Georgia State Board of Entomology:

Dear Dr. Quaintance:

I hand you herewith report of spray experiments with chemicals used as substitutes for arsenate of lead, in an effort to eliminate the objection to poisonous spray residue on the fruit.

These materials were put on at the same time as the arsenate of lead spray and at the strength suggested by the Bureau. Six applications were made with the following results:

Scorodite	60.1%	sound
Tri-calcium arsenate	31.6	"
Aluminum arsenate	50.9	"
Zinc arsenate	43.4	"
Magnesium arsenate	73.1	"
Manganese arsenate	25.0	"
Untreated	41.0	"
Lead arsenate	97.0	"

In these calculations all stung apples are considered as sound apples. You will note that of all these materials, magnesium arsenate was the only one that gave anywhere near satisfactory results and it was way below lead arsenate in efficiency in controlling the codling moth.

All of these materials burned the foliage, in some cases very severely so that the trees looked as if a fire had been through them. Arsenate of lead had practically no foliage injury and so far this year we have had no complaint on the score of objectionable lead or arsenical residue on the fruit

SUMMARY REPORT

of

DECIDUOUS FRUIT INSECT CONTROL

South Carolina Experiment Station
Division of Entomology and Zoology
and
Division of Horticulture Cooperating

Introduction

During the season of 1927, the Division of Entomology and Zoology and the Division of Horticulture began studies in the "Biology and Control of Certain Deciduous Fruit Insects." The plans arranged were tentative and used for the one season (1927) that better ones might be formulated for succeeding years in helping with the needs that would be found when intensive investigations began.

Because of the extreme importance of this problem at this time it is thought advisable to make these brief summary statements concerning the poison results, remembering that they are the result of only one year of work.

Report from

Summary of Results

Dear Dr. The oil emulsion "1-20" was used in the apple orchard of a commer- grower. About 1% of actual oil was used in the spray tank. The oil ved after the time scheduled for the first poison spray for codling moth. answe rees, not being in the horticultural orchard, made it difficult to get ling records. The control secured, however, was not as good as that secured the a the trees sprayed with lead arsenate. don

The 1-20 produced no ill effects on the foliage that were apparent. The stock emulsion did not mix as readily with water as it should for the greatest convenience of the grower.

A light white spindle oil was used also. This oil had the paraffins, gasolines, and kerosenes practically all removed. This emulsion was made with an emulsifier containing nicotine so that the final spray contained nicotine at a very low concentration.

The first application was made by using 4% of oil in the spray tank. Only the most healthy trees withstood this dilution. In the second application 2% of the oil was used in the spray tank. The healthy trees withstood this dilution very well. The unhealthy trees of those previously affected by the 4% oil spray were slightly injured. This refers to leaf injury. The season was finished with the 2% dilution.

The control of the codling moth from the emulsion made of spindle oil and nicotine was less than that secured from lead arsenate.

The viscosity of the spindle oil was very low. It was necessary use a very fine nozzle to prevent excessive "run-off."

A medium grade of lubrication oil was emulsified by using a nicot e emulsifier containing twice the amount of nicotine used with the spindle oil. This was used throughout the season at a 2% dilution. The control secured from this spray was better than that secured from the spindle oil spray but the additional nicotine may have been responsible for a rather large portion of the increase and perhaps all of it.

The leaves of one tree were "burned" with the first application of the medium emulsion. The cause for this has not been ascertained. The tree was apparently as vigorous as those not affected.

We used some oil emulsion with inert emulsifiers on soft-bodied larval chewing insects without any positive records of control and with some indications that more leaf area was eaten.

When using arsenicals, the best results in codling moth control were secured when lead arsenate was used. Magnesium arsenate did not give as good control but gave results which warrant further tests. Manganese arsenate gave results somewhat below magnesium arsenate. Results secured from calcium arsenate and containing 30% As_2O_5 produced results slightl lower

than magnesium arsenate. A calcium arsenate precipitated on ta taining 10% As_2O_5 gave less control than either the lead, magnesinate of manganese arsenate. Control secured from sodium fluosilicate was lications factory. We used zinc arsenate also but results were not obtained. of the arsenical poisons used caused any apparent injury to the apt foliage. sound "

From the plum curculio toxicity studies but few final conclusio be made. A late frost killed many of the blooms and left the crop "spotted" and but few varieties on which experiments could be conducted. The results may be considered as preliminary or may be used to compare with others of like nature.

In the fruit counts, the percentage of wormy fruit from the trees sprayed with lead arsenate, magnesium arsenate, and calcium arsenate were about the same and were small. No injury was evident on trees sprayed with lead arsenate and magnesium arsenate while there was shedding of a considerable number of leaves from trees treated with calcium arsenate.

The results from manganese arsenate were not as good as those from the three poisons mentioned above and those secured from sodium fluosilicate were much below that. Better results were expected from manganese arsenate in view of the favorable results secured from cage tests with truck insects. Neither the manganese arsenate nor the sodium fluosilicate caused apparent injury to the peach foliage.

A dust made of 5% magnesium arsenate, 47-1/2% lime, and 47-1/2% talc v to /e poor results. These results were below expectations and have not been tisfactorily explained as yet, especially in view of the success of the est using the magnesium arsenate as a spray. The physical properties of his arsenical are not good. It does not mix with diluents to make as good dust as calcium arsenate and certain other arsenicals. This may explain its failure.

The physical properties of magnesium arsenate should be improved. The product has too great a density and packs too readily. The moisture content may be too high, as the product appeared moist in addition to the softness due to the magnesium.

By:

C. O. Eddy

and

W. T. Henerey.

Report from Prof. Garcia, New Mexico Agricultural Experiment Station:

Dear Dr. Quaintance:

On my return from Chicago I find your letter of November 7, and the answer to it on my desk. During the year we have made a change in our codling moth project. Since all apples have to be washed in order to remove the arsenical residue, we have felt that there ought to be some more work done along the line of whether or not it is possible to attack successfully the adult moth instead of the larva. With this in view, we started this fall some new lines of codling moth investigations in order to see if it is possible to get rid of the larvae and the moths. We hope to get this work pretty vigorously under way next spring.

We have also started a project in the chemical laboratory to get some idea as to the amount of arsenic on the apple before and after it is washed. Professor Botkin, of the Chemistry Department, has made quite a number of analyses on this subject and the following are some of the results which will be of interest I am sure.

Date 1927		Sample	Source	No. Sprays	Treatment	Grains As_2O_3 per lb.
July	2	Apples	Las Cruces	2	Unwiped	0.016
"	2	"	" "	2	Wiped	.003
"	28	"	Roswell	4	Unwashed	.020
"	28	"	"	4	Washed in HCl	.003
August	13	"	Albuquerque		Unwashed	.0189
"	13	"	Roswell		"	.020
"	13	"	"		"	.019
"	13	"	"		"	.037
"	13	"	"		"	.030
"	13	"	"		"	.061
"	16	"	"		Washed in HCl	.005
"	16	"	Ft. Sumner	3	Wiped	.005
"	24	Cider	Roswell		Unwashed apples	.028
"	25	Apples	"		Washed in HCl	.007
"	25	"	"		Unwashed	.018
"	27	"	Alamogordo	2	?	.001
"	30	Vinegar	Roswell		Unwashed apples	.021
Sept.	2	Apples	"		Unwashed	.030
Oct.	3	Vinegar	"		Unwashed apples	.035
Oct.	3	"	"		" "	.021

Of course these figures simply show the work for one season. We hope to continue it next year.

Yours very truly,

(s)Fabian Garcia.